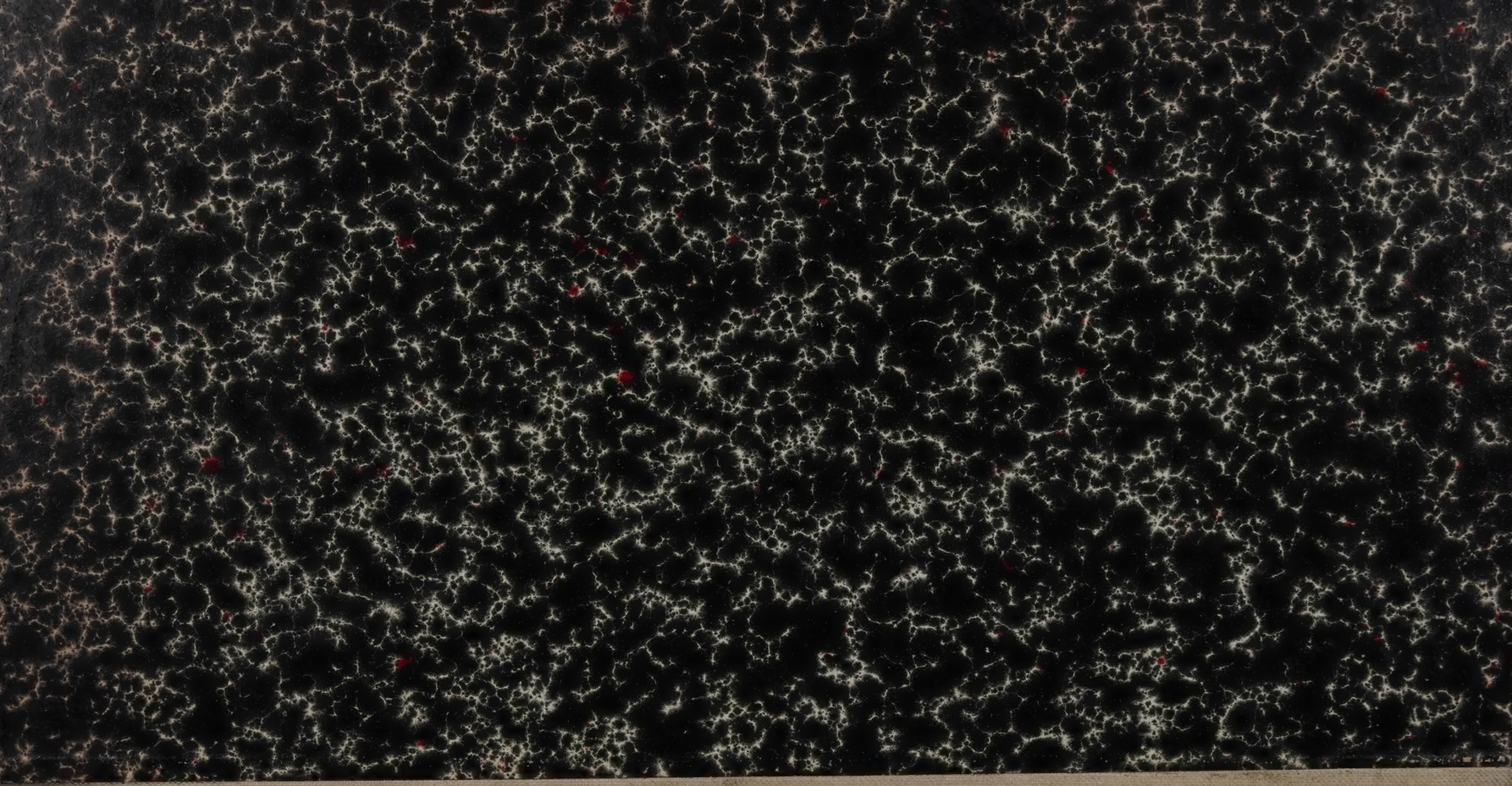

E.W. CLAYPOLE - Traces of Ice Age in Flora of Cuyahoga Valley.

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TRACES OF THE ICE AGE

—IN THE—

Flora of the Cuyahoga Valley

—DELIVERED BY—

PROF. E. W. CLAYPOLE,

OF AKRON, OHIO,

BEFORE THE WESTERN RESERVE HISTORICAL SOCIETY, OF

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TRACES OF THE ICE AGE IN THE FLORA OF THE CUYAHOGA VALLEY.

E. W. CLAYPOLE.

Among the revelations of Geology the great changes of temperature which parts of our globe have experienced in comparatively recent times are not the least surprising. So strong is our association of the pole of the earth with a cold climate that it is not easy to conceive of it in any other relation. Yet no fact is more certain than that this connection has not always been actual. So also the existing temperature of the temperate zone has not always prevailed. The testimony of geology is conclusive on both these points.

If we look back into the Tertiary Era to the beginning of the Miocene, or perhaps to the end of the Eocene age, a very different state of things meets the eye. From the cold and ice-bound north come fossil plants which tell us a story, at once strange and true, of those countries as they then were —not the dreary wastes of to-day, but warm and green and beautiful as our own land in our own time.

Collections of vegetable fossils from Disco Island, in West Greenland, in 78° of north latitude, have revealed to us a rich and varied floral growth indicating, if not warm, at least mild temperature, when trees, which cannot in our days stand in Ohio, could live and grow on the shores of Baffin Bay and Davis Strait, now clogged with the terrible "Middle Ice" of the polar current. Examination of the fossils by botanists, especially by the late Prof. Heer, of Zurich, enabled him to draw up the following list:

		Disco.	Spitzbergen.
Salix,	Willow,	P	...
Populus,	Poplar,	P	P
Corylus,	Hazel,	...	P
Tilia,	Linden,	...	P
Alnus,	Alder,	P	P

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Quercus,	Oak,	P	...
Fagus,	Beech,	P	P
Platanus,	Plane,	P	P
Juglans,	Walnut,	P	...
Salisburia,	Ginkgo,	P	...
Liriodendron,	Tulip tree,	P	...
Vitis,	Vine,	P	...
Thujopsis,		P	...
Taxodium,	Bald Cypress,	P	...
Sequoia,	Giant Redwood,	P	....

Any one familiar with the forests of our State and the nature of their trees will be deeply impressed on reading this list. Though it may cause him no surprise to see the first few names, because the Willow, Poplar, Hazel and Alder are among our hardiest trees and range far to the northward over Canada at the present day, yet the Oak and Beech seem strangely out of place for they are far more tender; the White Oak not ranging north of Ottawa, the Red Oak being scarcely found on the north shore of Lake Superior, and the Bur-Oak, the hardiest of its genus, only reaching even in the west to the Prairie Province and Winnipeg Lake.

The Beech is a little less hardy and occurs rather less to the north than the Red Oak. The Plane is not fully hardy even in Ohio being often killed by spring frosts. The same is true of the Tulip-tree, which scarcely crosses the Niagara and St. Lawrence. The Vine and Walnut hardly enter Canada except in the Ontarian peninsula and on the Atlantic coast. The Japanese Ginkgo, planted through the Eastern States, is scarcely able to bear the winters of the Northeast and of Ontario and Quebec without protection, and never fruits save in very favorable surroundings, while the Bald Cypress and the Redwood, as is well known, only grow where the winters are mild, as in the Southern States and in California, to a few spots of which latter Sequoia is now confined.

Let us then, if we can, imagine the earth's condition when it was clad with all this luxuriant forest growth as far as 78° of North Latitude. It is a legitimate inference that no severe winter was then experienced in those regions and that the climate was milder than that of Ohio at this day, and probably resembled what now prevails in California and on the West Coast generally.

Yet again we may further infer that if Taxodium and Sequoia could flourish within 12° of the pole, the hardier genera could range yet farther to the north, and the Willow, Poplar and Alder could grow at the very pole itself, supposing land to have existed there. In any case, it is almost beyond doubt that no icy sea or snow-clad land was there, and that the North Frigid Zone was then as accessible as the Equator, had man been present to traverse it.

But this glorious Miocene or Eocene Summer passed away. Slow changes, whose causes are as yet unknown, reduced the temperature age after age until the trees migrated south or died out and the snow and ice assumed undisputed possession of the Polar region. Toward the end of the next era, the Pliocene, the empire of frost slowly extended itself over the North Temperate Zone until, in the Pleistocene, much of it became what Greenland is now, and the Ice-Age was at its zenith. All Northwestern Europe and Northeastern America were hidden beneath the icy mantle or only a few of the highest peaks raised their heads, as the "Nunataks" of Greenland, above its concealing sheet. Every living thing was driven southward before it. Animals migrated; plants died and their seeds alone, borne to a more genial clime perpetuated the species. When migration was impossible, extinction was the only alternative.

But in time nature relented and the ice-sheet began to retreat. Slowly the country was uncovered in reverse order and the hardiest plants and animals, among the latter of which was man, ventured northward close to the edge of the receding ice. As the retreat continued the denizens of

warmer regions trod on the heels of the hardy pioneers and pushed them farther and farther northward, usurping their place. Conditions that suited the former disagreed with the latter and they retreated to the Arctic Regions or to the mountain tops. In this way vegetation was again distributed over the continent and resumed its former abundance, but not its former luxuriance, for the Miocene mildness has never returned. The chill of the ice yet lingers over the North Temperate Zone, and its effects are visible wherever opportunity offers.

One of these opportunities is in our own district. In the cool moist glens of the Cuyahoga Valley there yet linger traces of a northern flora, and the botanist whose ken takes in more than the mere outside of his science, who seeks the history and the ancestry of his pets, and asks himself how they came where they now are, finds no little pleasure in seeing, as it were, the footprints of the ice-king on the ground before him.

The flora of these glens contains, among others, the followlng species whose most congenial habitat is farther north, though several of them range southward when and where conditions favor them.

Hemlock Spruce (Abies Canadensis)	common north, rare south.
Arbor-vitæ (Thuja occidentalis)	" " " "
Canada Yew (Taxus Canadensis)	" " " "
Mountain Maple (Acer spicatum)	Me. to Wis. & Alleghanie
Canoe Birch (Betula papyracea)	Almost entirely N. & N. W.
Red-berried Elder (Sambucus pubens)	N., S. in mountains.
Purple Raspberry (Rubus odoratus)	common northward.

Calla (Calla palustris)	common northward.
Swamp Saxifrage (Saxifraga Pennsyl.)	common, especially northward.
Gold Thread (Coptis trifolia)	N. & S. in mountains.
Long Club-moss (Lycopodium lucidulum)	common N.

Without insisting strongly on every one of these cases we may assert that the aspect of this flora is decidedly northern, and that it would be difficult to explain its presence in the Cuyahoga Valley had the temperature and conditions been always as they are now. And when further we recollect that nearly all the glens and valleys of similar nature in the glaciated region as far south as Southern Indiana are in like manner occupied by a northern flora, the impression deepens and it becomes impossible to escape the conclusion that our state has recently recovered, or is, perhaps, even now recovering from a great depression of temperature—a "cold snap" of no short duration. In short, the Botanist fully bears out the conclusion of the Geologist regarding the great ice-age.

The story above given of the migration of plants and animals, from the north to the south and their partial return, is confirmed by another set of facts the consideration of which requires a wider view and a more extensive range over the field of Biology. When the Botanist compares the floras of the Old and New Worlds he is struck by the fact that there is a marked resemblance between them and yet a substantial difference. Frequently the same genus is found on both hemispheres, but the species are different. In not a few cases the similarity is yet greater and the same species occurs on both showing only varietal differences. In yet another set of cases no distinction at all can be drawn between the eastern and the western forms and the botanist is compelled to admit their complete identity. How can these

things be? How can plants so nearly or completely alike occur at so vast a distance from one another?

As illustrations of this statement, we may quote the oaks, of which several species occur in Europe and perhaps more in America, and yet no two are alike; the willows with sixteen American and fifteen English species, of which one only is common to the two continents, (S. herbacea,) and that the smallest only attaining the height of two inches and arctic in its taste, occurring on the White Mountains of New Hampshire and at high elevations in Britain; the Poplars with six American and three English species, all different; the apples, with five species on each continent, but none identical; the Golden-rods, with one species in England and thirty or forty here, and the Heaths, of which six species grow in England, only one of which is found, and that very rarely, in America.

The same is true of smaller genera of which we may quote the Hornbeam with two species (Carpinus Americana, and Ostrya Virginica,) in America and one in Europe; the Beech, Chestnut and Linn, with a single species on each side of the Atlantic, scarcely distinguishable; the Hazel and Strawberry with two American and one English species, and the Elm with two English and one American.

Coming down to still closer resemblance we find many species, especially those of northern affinity, common to both hemispheres. One of the most showy and abundant of arctic flowers, the Rosebay, (*Epilobium angustifolium*,) inhabits Europe, Asia and America. A Violet, (*V. canina*,) is found in both worlds, and the Marsh-marigold, (*Caltha palustris*,) with its large yellow flowers, colors in spring the swamps of Europe and America. Two Sundews, (*Drosera rotundifolia* and *D. longifolia*,) open their leafy traps in both hemispheres, and the Harebell, (*Campanula rotundifolia*,) so well known to every tyro in botany, hangs its purple blossoms from the crevices of rocks in the northern parts of the eastern and western worlds. Not a few plants are truly

circumpolar and range around the globe from Western Europe through Asia to Northern and Arctic America. This is the case with all those just mentioned. They greet the botanist as he travels around the world. They are citizens of no country in particular but so far as conditions suit them they are cosmopolitan.

If we may be allowed to add a single additional fact to the strong case already presented, we would cite the Ferns. And taking no wider view of this family than is shown by the comparison of the Fern-flora of the Eastern United States and England, we find that out of between fifty and sixty species that are natives of the former, about one-half are also indigenous to the latter. In no family does the European botanist find more constant reminders of his old home than when he is working among these plants. In most instances he can detect no difference between those which he gathers here and those which he has collected on the other side. So close a resemblance between two floras can admit of no rational interpretation save community of origin in the distant past. The Ferns of the East and of the West are cousins, though their common ancestral home has been destroyed and its memory almost effaced by the disastrous physical changes that have supervened.

One of the most beautiful little gems of the Swiss Alps, well known to every botanist who has visited them by its starry flowers and feathery seed-vessel, (*Dryas octopetala*,) the Dryad of the limestone ridges, well exemplifies the fundamental facts of this paper. Its range is from England and Scotland to Arctic Europe, Asia and America, extending south to the high mountains of Switzerland and of Colorado and through British America to Greenland. Nor is this pretty little Rosewort alone in its wide range and unexpected appearance. Such facts might be multiplied in almost endless succession. But enough have been given to suggest the question, how can they be explained?

Fifty years ago the query would have had no significance

because the problems of Evolution had not been propounded. But to the present generation such resemblances can only be explained on the theory of descent with modification. The family likeness indicates a common origin. The Beech of Europe and the Beech of America must have sprung from a single ancestor at some time in the past. So also with the two Chestnuts, the three Hornbeams and all the others. What solution has geology to give to this botanical problem?

Revert for a moment to the Tertiary history of the Northern Hemisphere and realize the Arctic luxuriance of the Miocene Era as already described. Transport all these plants back to their polar home and watch their slow southward migration with the secular cooling of the climate. Recollect too what is meant by the migration of a plant, and note how it differs from that of an animal. The animal travels, or can travel, in most cases, during its whole lifetime, so that its offspring may start in life many miles from the spot where its own individual existence began. But the plant has no such power of locomotion. Where it springs from the ground there it remains till it dies. The species can, in most cases, only travel through their seeds, which may be carried or drifted to some distance—or may not. Obviously, this is a slow and uncertain process in which chance takes by far the greater part. An annual plant, seeding every year, has an immense advantage over a tree, which may not produce seed till it is twenty years old. Yet even an annual plant can in most cases, and barring external help from wind, currents and animals, travel but a short distance every year and during its retreat it was pressed close in the rear by the advancing ice and cold. How many of the Miocene occupants of the Polar Regions failed to make their forced march to the southward quickly enough to escape their pursuer and were consequently overtaken and ruthlessly extinguished we may never know. But apparently the absence of many Miocene species from Europe is

due to this accident. The Hickories, the Red Maple, the Sweet Gum, the Western Plane, the Fox Grape, the Bald Cypress, the Tulip-tree, the Fan Palm and the Sequoia , all lie buried in the Oeningen beds of Switzerland but survive in North America where southward migration was not blocked by the Alps, the Pyrenees and the Mediterranean.

These features of the European geography, especially the last, were very fatal to the inhabitants of that continent during their migration. Stretching, as did the Mediterranean, a long unbroken barrier accross their path, it left them no way of escape, and when caught between it and the cold, many of them perished. Hence the forests of Europe lack numerous species which still survive in those of North America. These latter retreated to the south during the cold era and returned with the rising temperature to their old haunts, thus escaping the extinction which overtook their less fortunate brethren of Europe.

Nature, to the student of science, is full of such accidents. She mercilessly destroys the work of her own hands and shows that the organic world is but as it were a plaything in the hands of the inorganic. Amid the changes and catastrophes of the latter, the former must take its chance, surviving if it can and if it cannot perishing and forever; for the type once lost is never renewed.

Of those that survived this disastrous retreat before the advancing hosts of the ice-king, we find the descendants scattered over both hemispheres, and so distributed that the flora of Eastern Asia shows a strong resemblance to that of Eastern America, where the climate is severe while the plants of Western Europe have, in many cases, their nearest allies on the west coast of America where the climate is mild and moist.

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*Note.—In regard to a few of these trees there is some doubt among botanists whether or not the species were precisely identical but at most the differences are only varietal.

To the evolutionary geologist the case as above stated presents no difficulty. He sees the plants slowly retreating before their foe, and adapting themselves to changes of environment as best they could. Some show no alteration, as the Harebell and the Dryad, mentioned above. Others show differences regarded by most botanists as merely varietal, such as the Chestnut, Beech and Sequoia, etc., though by some these are regarded as distinct species. In other cases the variation has gone so far as to constitute clearly two species of the same genus.

But in all this he finds nothing at all surprising. It is not more than he would expect considering the enormous lapse of time which these migrations have occupied and the wonderful changes of environment to which the emigrants have been subjected. He sees with satisfaction the deductions of botany confirming those of geology, and the most difficult and apparent inexplicable problems of the one science receiving a complete solution from the deductions of the other. Thus they are mutually supporting and by the efforts of the students in both departments is the story of continuous life on the globe being gradually recorded.

Digressing a little I may be allowed to introduce an illustration from another science. There is a species of butterfly, the "Goddess of Mt. Washington," (*Oeneis semidea*,) which haunts that mountain alone, so far as we know, in the Eastern United States. But it reappears in the West on Pike's Peak and is an Arctic insect. To explain its presence in these two places on any other theory would not be easy, and this butterfly is accordingly regarded by zoologists as a relic of the ice-age, exterminated on the plains by the rising temperature and only lingering on the cold heights where conditions are still favorable.

The moral of my story is that physical changes leave on the region where they occurred, and on its living residents traces, which if not indelible, are yet very long lasting, and that these records may be read and interpreted by him who

has learned the language in which they are written. An eminent botanist, lately lost to science, once said that if all historical records were destroyed and the white race exterminated from the Western World, the fact of its presence here would be demonstrated by the botanist from the weeds of Europe that infest our fields. So the botanist could in the same way, from a study of the flora, come to the conclusion that there has been in the recent stages of the Earth's history a time when the climate was much colder and more ungenial than it now is in the North Temperate Zone. He is slowly learning the characters in which nature has recorded these events and is engaged in translating them into the language of man.

Not many years ago the marvellous history of Egypt was totally unknown. The mysterious characters graven on the tombs and temples of the new and old empire, though eloquent, were dumb to the historian. Not until the Rosetta stone, with its trilingual inscription was discovered, could we obtain any historical knowledge of this the most wonderful of ancient empires. But now, thanks to the labors of Champollion and Young and their disciples and followers, we are translating the story recorded on the monuments and dug from the ruins into the language of the modern world, so that he who runs may read, and the procession of Egyptian kings and the succession of Egyptian people stretches farther and farther back into the past till both are lost in the dim mist of an antiquity far older than the date formerly assigned to the human race, or even to the earth on which it lives. The true story of Egypt, as told by the critics and the historian, far surpasses in interest any imagination that we formerly entertained regarding the significance of those mysterious hieroglyphics.

So the botanist and the geologist are engaged in deciphering the records of nature graven with an iron pen in the rocks almost forever, and translating them into a tongue that is "understanded of the people." And it is not too

much to say, even of the recent developments regarding the Ice-age, that no story that poet ever feigned comes up in marvellous interest to that which reveals to us the icy region of our earth clad with beauty and fertility, the home of temperate and almost semi-tropical life, and then anon the Temperate Zone overspread with continuous sheets of ice and snow which blotted out of existence all this teeming life and beauty and reduced it to a waste and howling wilderness—a Greenland vastly magnified and enduring for millennium after millennium—and finally its redemption in part from this desolation and its restoration to fertility and fruitfulness. Yet this is the story told, not by the fancy of the poet or novelist, but by the sober, solid deductions of the Botanist and the Geologist.

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